Luminous Region in DØ

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- Definition of the Problem
- Measurement using vertexes
- Measurement using pairs of tracks
- Results and comparison
- Plans and conclusions

Bram Wijngaarden also spent some time looking at this problem, the distance makes the collaboration a bit harder, we will prepare a more complete document including his studies.

What are we trying to measure?

- The proton and antiproton beams are focused in the DØ and BØ interactions regions (low beta magnets), but we need to know:
  - Do we have the focusing that the beams division expects?
  - Is this focusing stable beam at DØ?
  - Can we explain the difference between the DØ and CDF measured luminosities by taking into account differences of the beams in the two interaction regions? (this is the part of the problem that I was trying to understand as part of the work with the beams instrumentation, SDA).

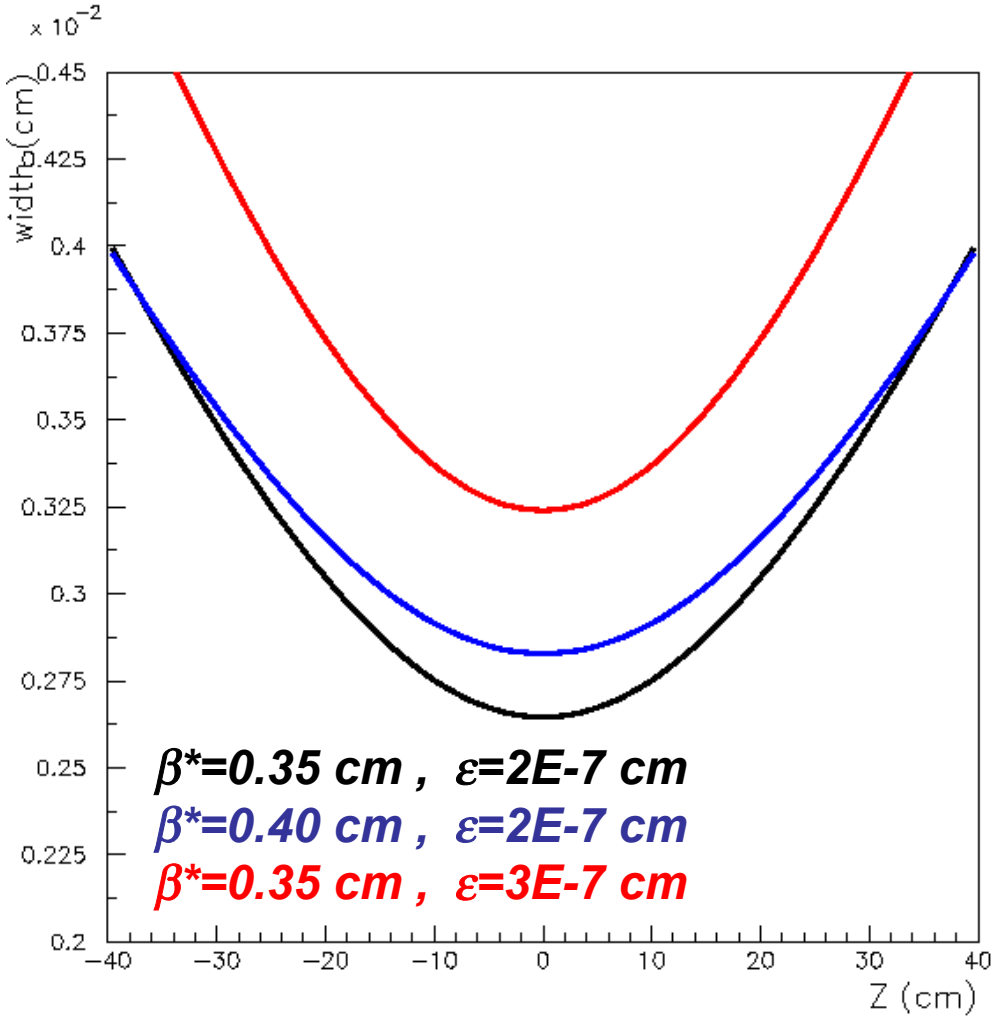
What we expect

The interaction region is a drift in the Tevatron, one expects.

$$\sigma^2 = \varepsilon_{eff}\left[\beta^* + \frac{(z - z_0)^2}{\beta^*}\right]$$

$$\varepsilon_{eff} = \frac{\varepsilon_p \varepsilon_{pbar}}{\varepsilon_p + \varepsilon_{pbar}}$$

In the beams division they expect ***β*=0.35 cm.***



Using vertexes

- Given a distribution of vertexes (x_i, y_i, z_i) then observed width is:

$$\sigma^2_{obs} = \sigma^2_{beam} + \sigma^2_{vertex}$$

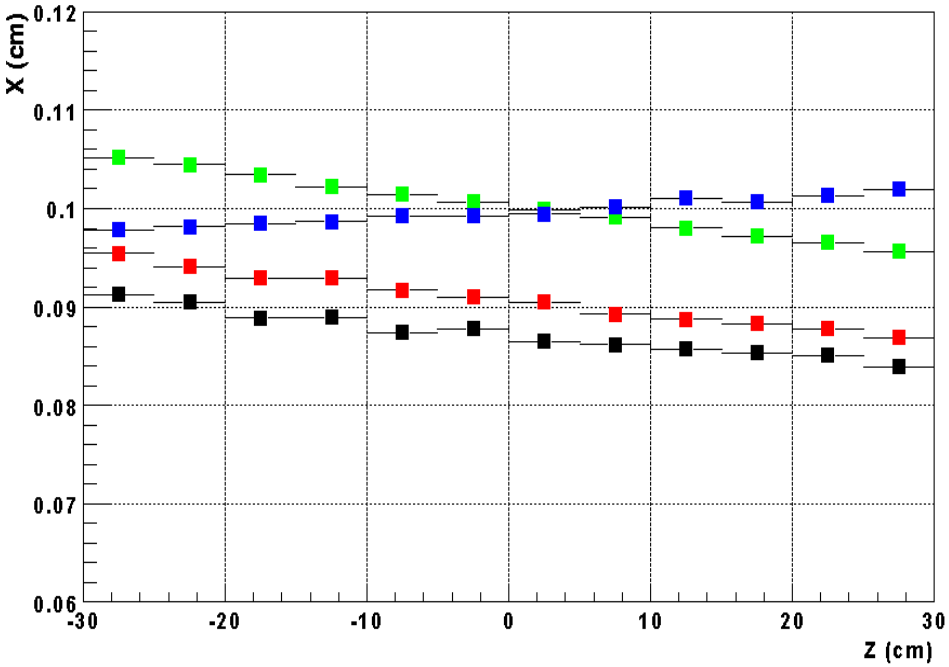
- σ_{beam} = *width of the luminous region*
- σ_{vertex} = *error in the vertex position*

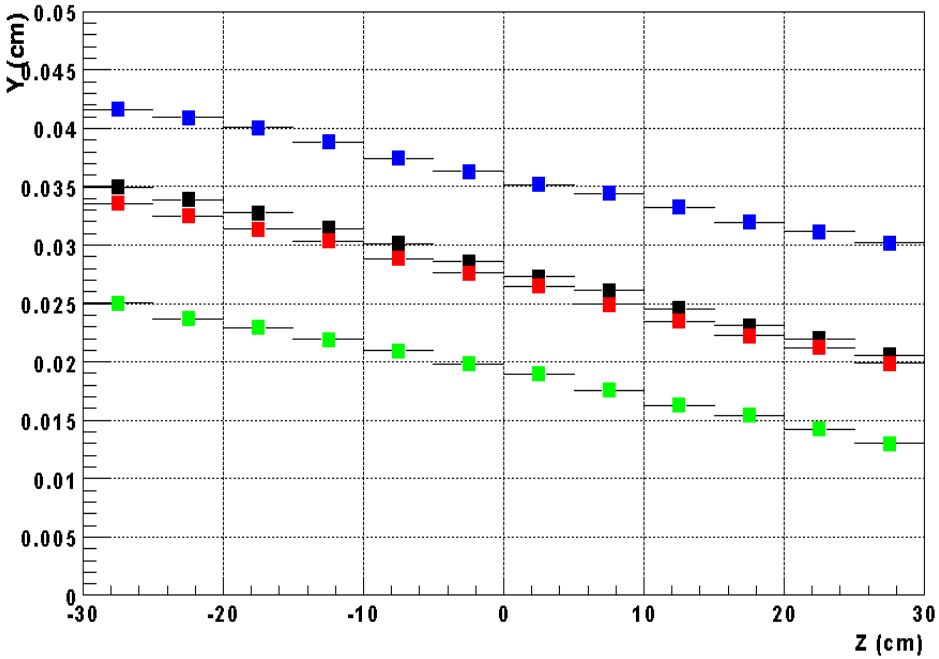
The problem is that the estimation for σ_{vertex} that we get from Reco is an smaller than the real error in the vertex, that is why we have to consider:

$$\sigma^2_{obs} = \sigma^2_{beam} + k \times \sigma^2_{vertex}$$

…we have to find *k* from the data doing a linear fit

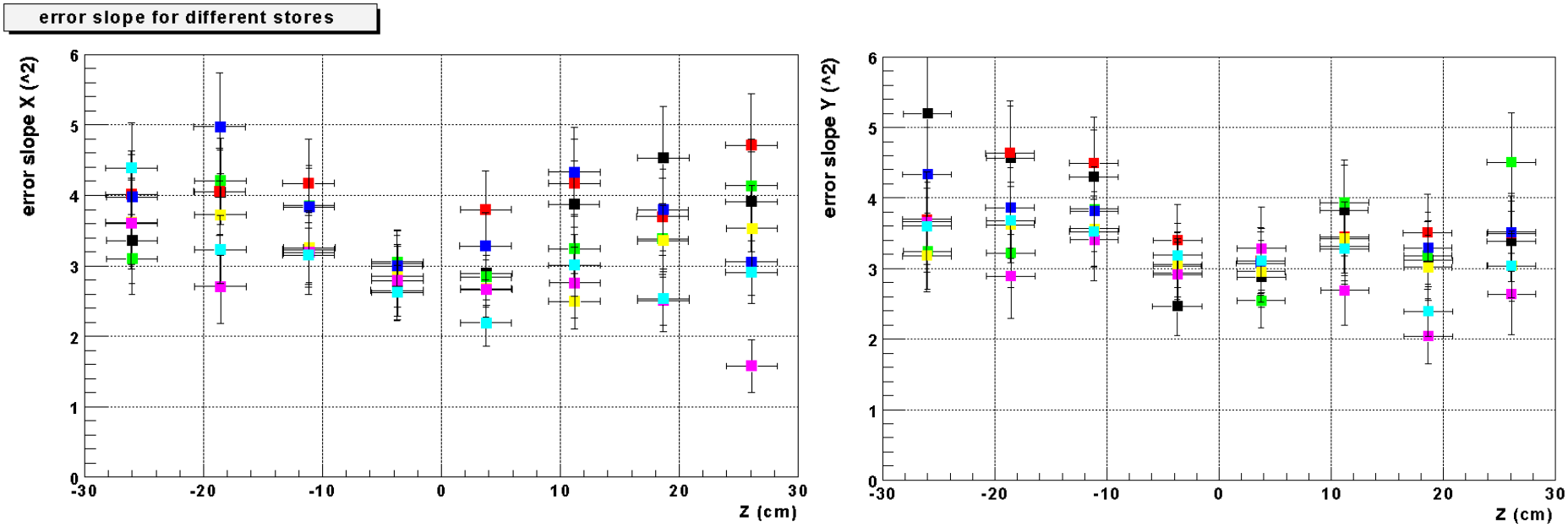
Taking into account the beam tilt





4 runs in different stores reconstructed with p14.01 . The plots show that the beam can move more than 100um from store to store (stores **2312,2315,2341,2420**)

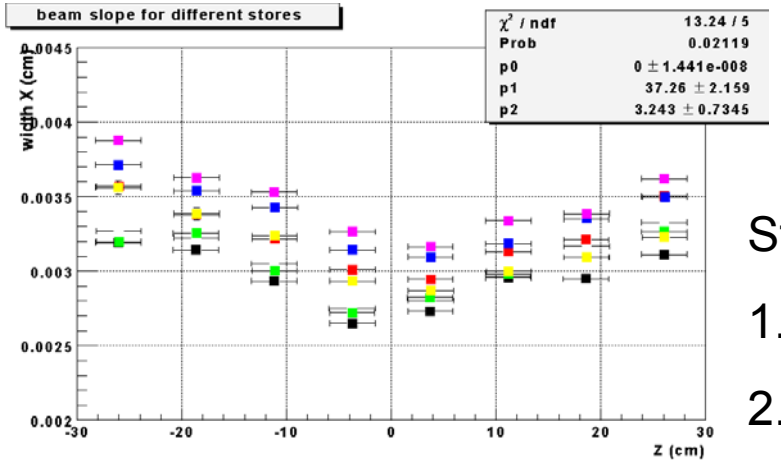
Finding *k*



The linear fit is done for many runs in different stores in bins of Z. The results indicate that the error in the vertexes is underestimated but as much as a factor of 2 (this was discussed with G. Berissov and he thinks it is reasonable). We take the average for all these runs and that is what we use for ***k***.

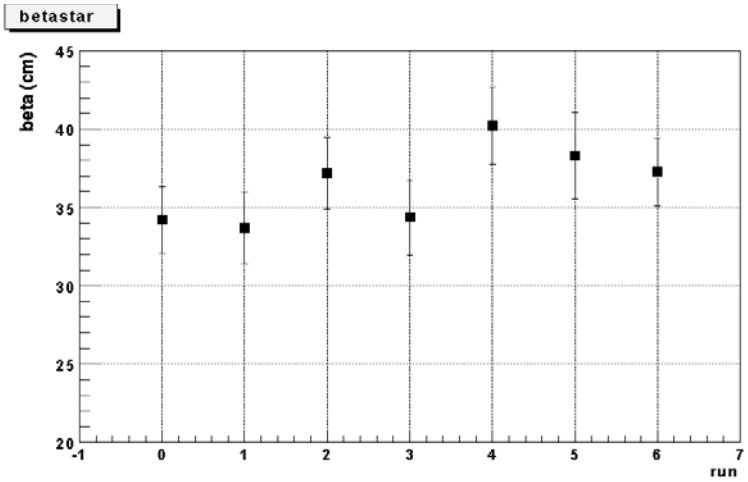
Using p14 and only vertexes that have at least 7 tracks.

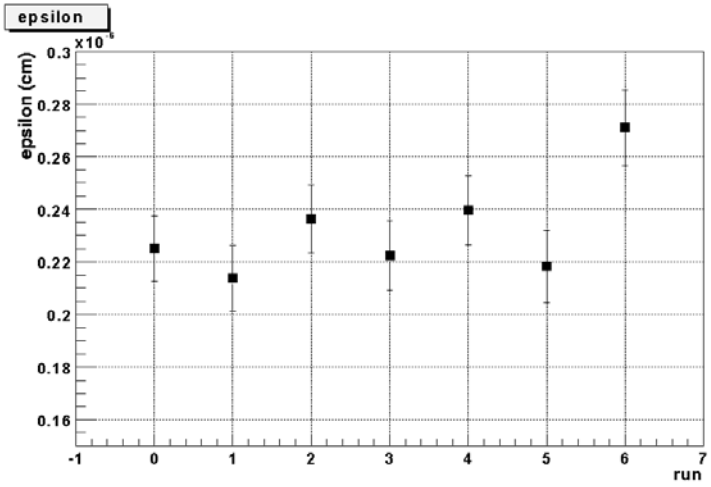
Results for X

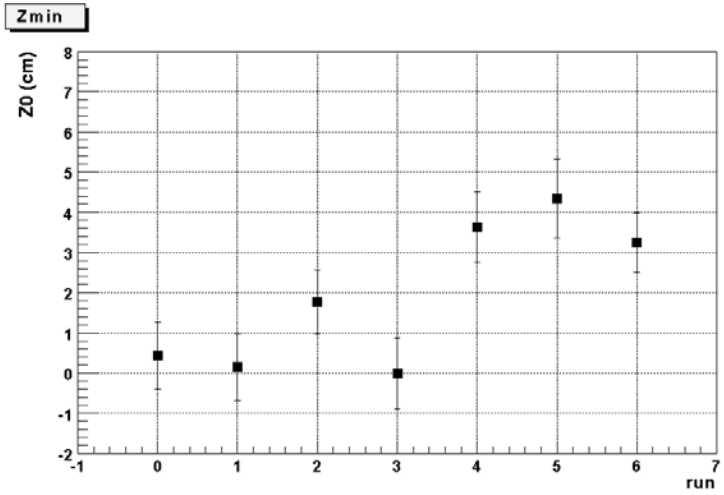


Stores:

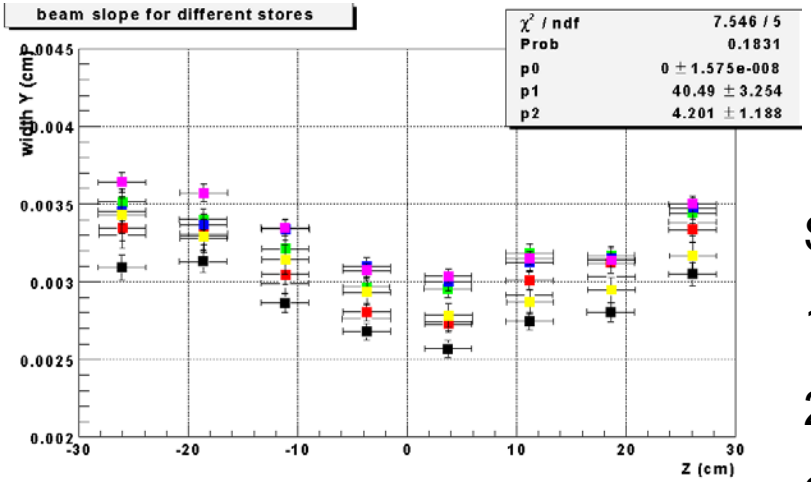
1. 2312
2. 2315
3. 2341
4. 2420
5. 2507
6. 2523
7. 2540







Results for Y



Stores:

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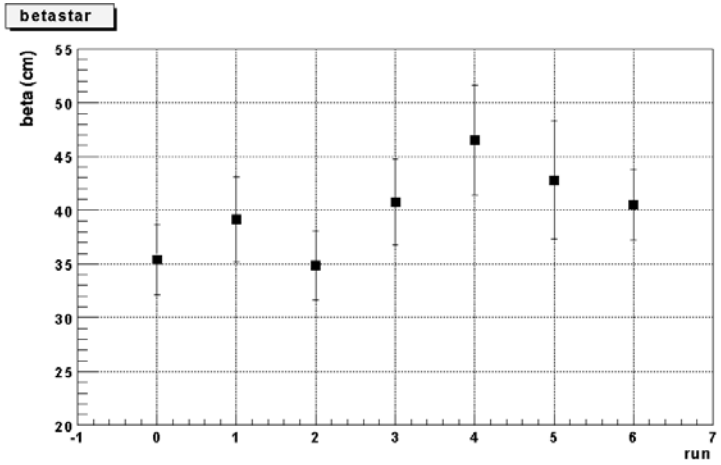
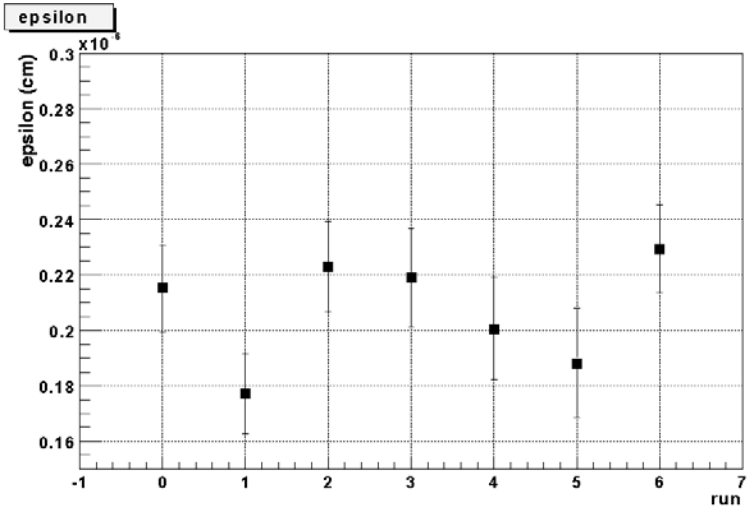
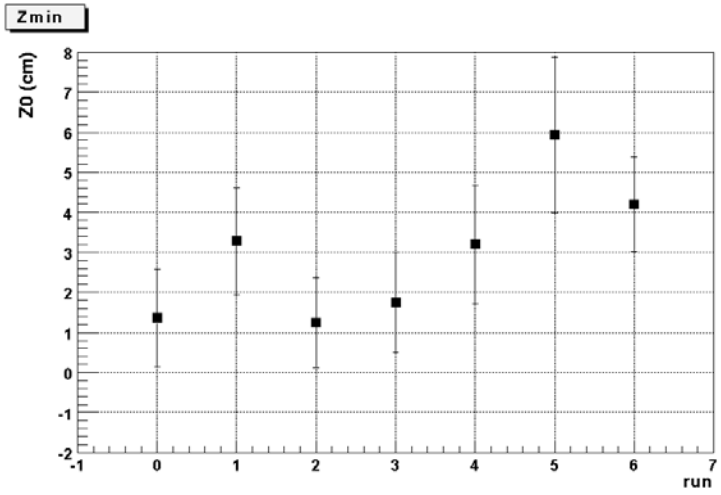
7. 2540







The track pairs method

- There is another way to do this measurement using the dca parameter for the tracks:

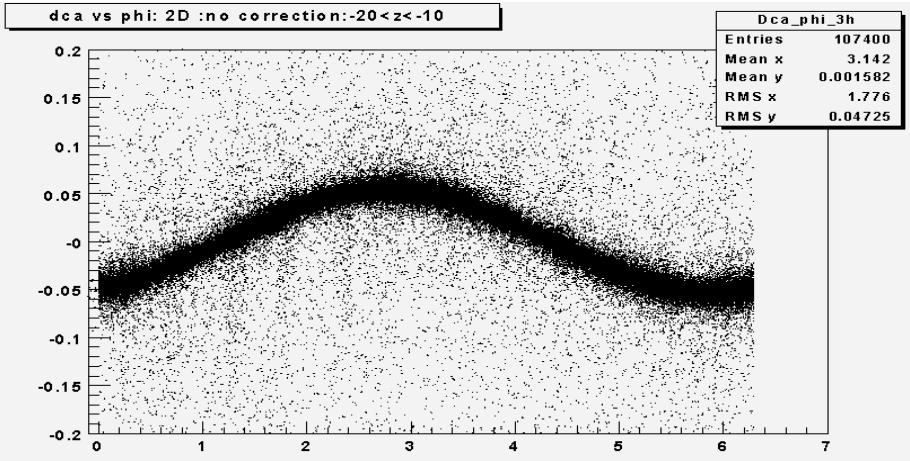
$$d_i = y\cos(\varphi_i) - x\sin(\varphi_i)$$

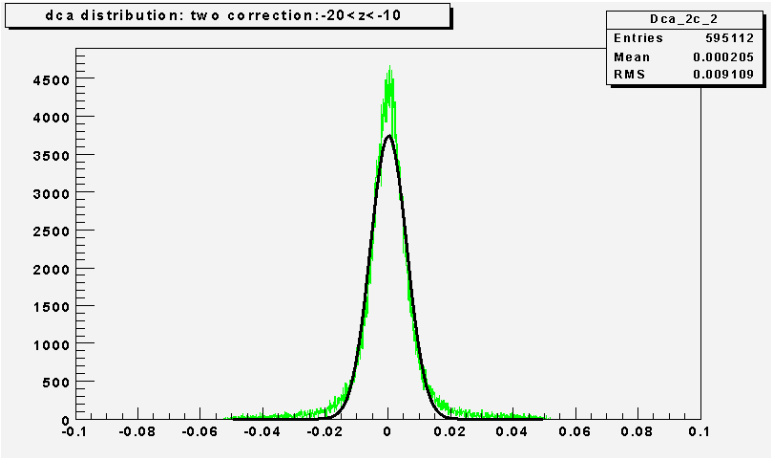
$$\langle d_1 d_2 \rangle = \sigma_F^2 \cos(\varphi_1 - \varphi_2)$$

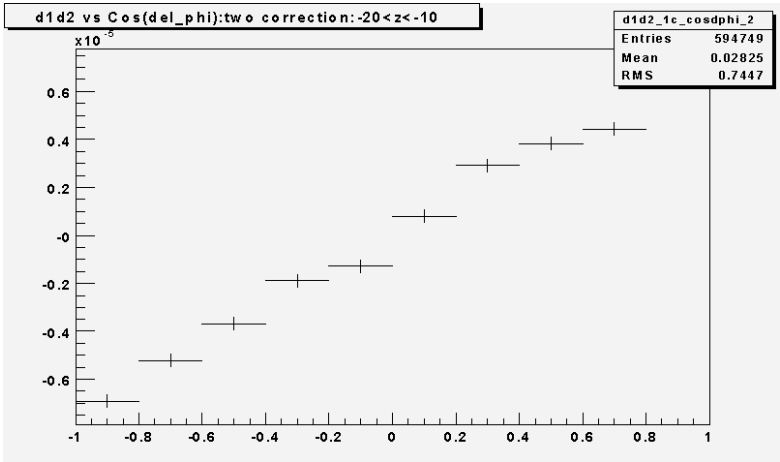
Here we assumed a circular beam… if the beam is not circular the relation is a little more complicated, we do the analysis in both cases.

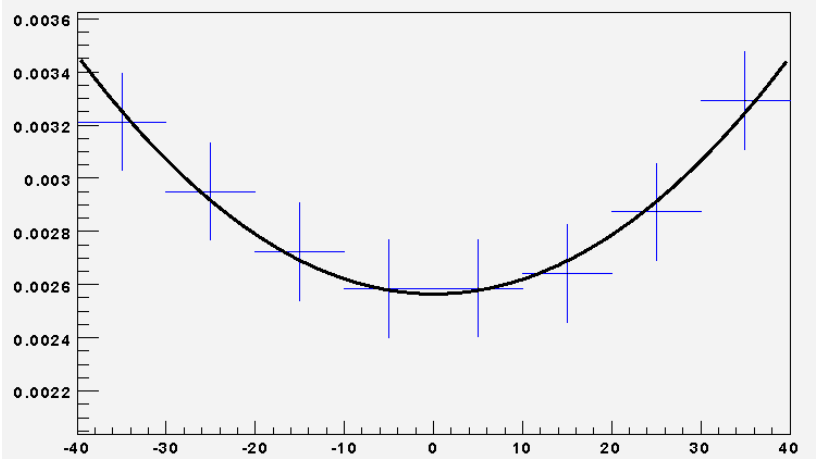
It is easy to see that if you **include uncorrelated measurement** errors for this tracks, the equation does not change. The error terms cancel in the formula above.

Example

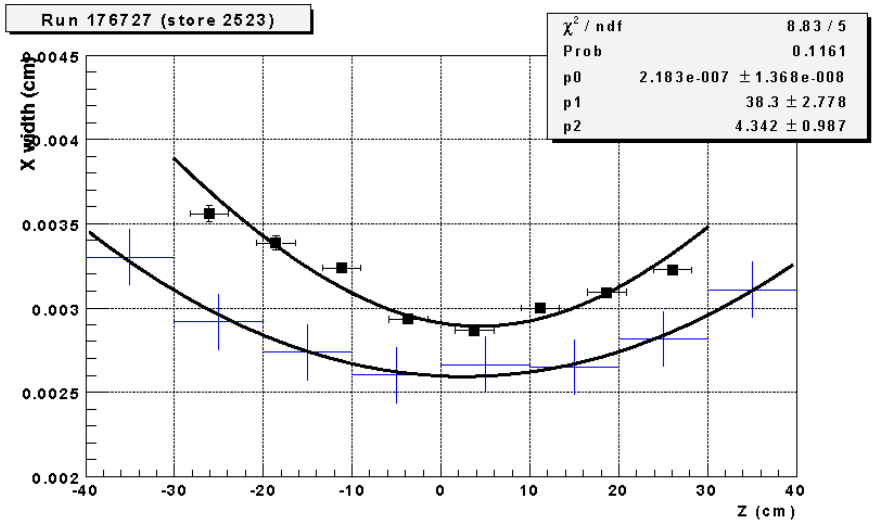

dca vs phi: 2D :no correction:-20<z<-10
Dca_phi_3h
Entries 107400
Mean x 3.142
Mean y 0.001582
RMS x 1.776
RMS y 0.04725

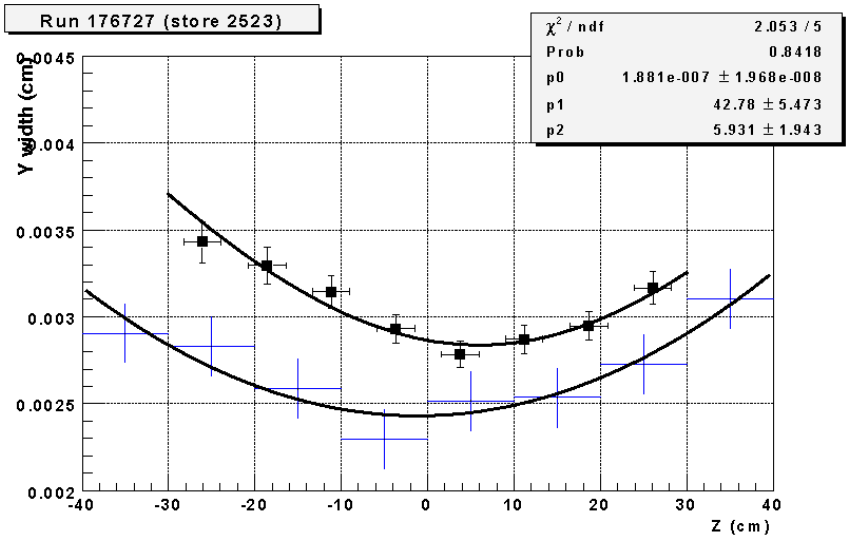

dca distribution: two correction:-20<z<-10
Dca_2c_2
Entries 595112
Mean 0.000205
RMS 0.009109


d1d2 vs Cos(del_phi):two correction:-20<z<-10
d1d2_1c_cosdphi_2
Entries 594749
Mean 0.02825
RMS 0.7447



Comparing results

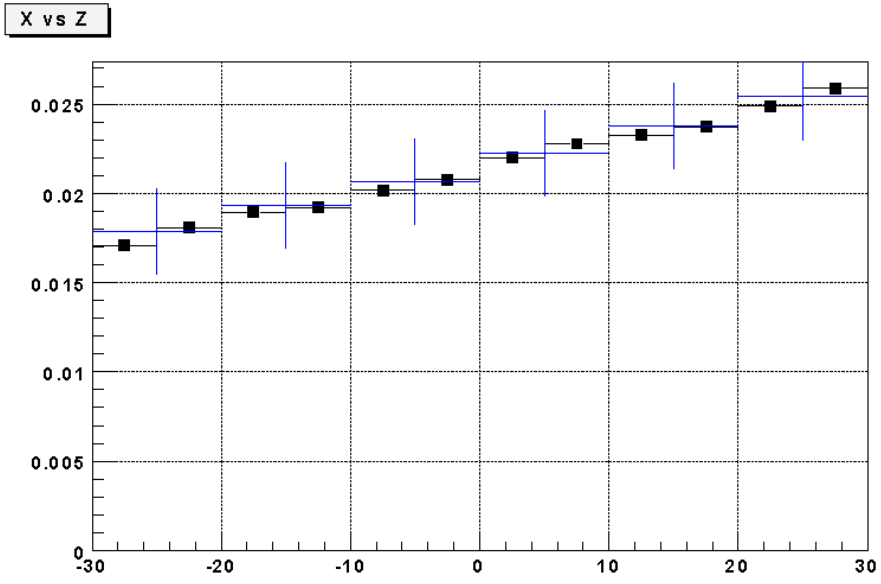


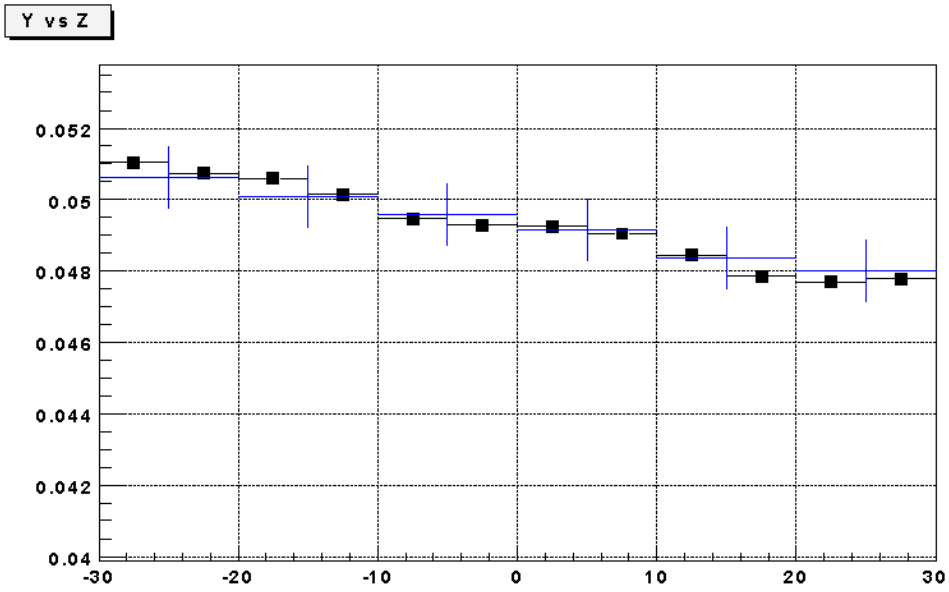


The method that uses the vertexes gives consistently a beam that is 3-5 um larger in width and with less curvature (larger β*). We do not understand this difference, the tracks are correlated and maybe the track method is somehow affected by this correlation… still investigating this problem.

(vertexes in black and tracks in blue) All scales in cm.

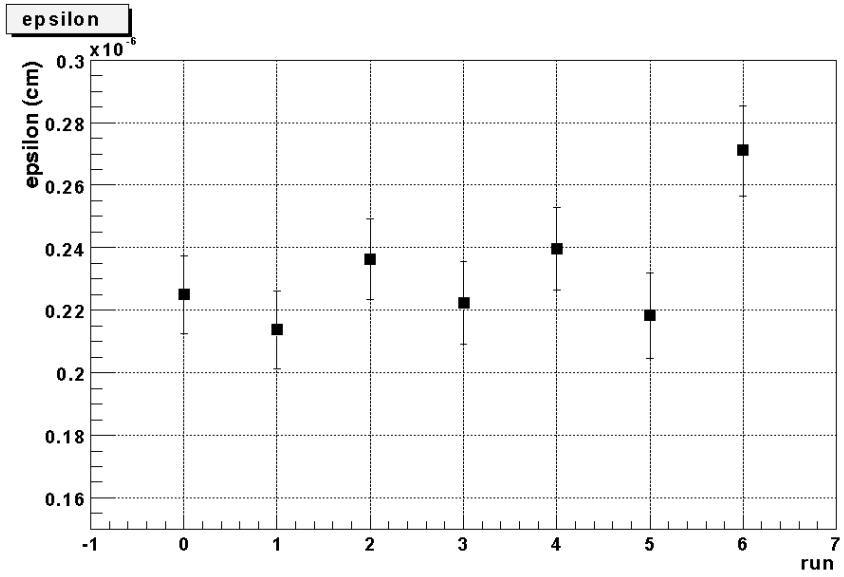
Comparing results



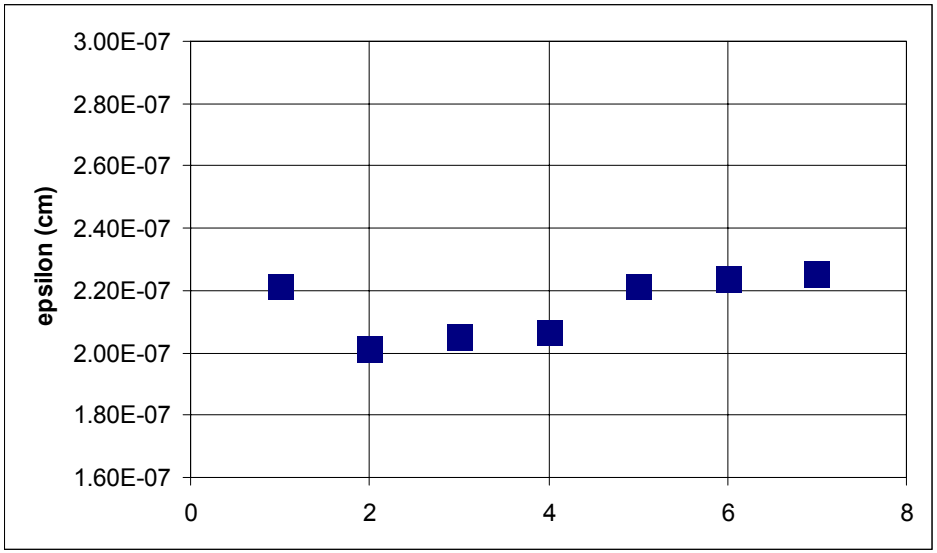


The beam position is the same, when measured with the two methods (vertexes in black and tracks in blue). All scales in cm.

Comparing our emittance with Tevatron measurements



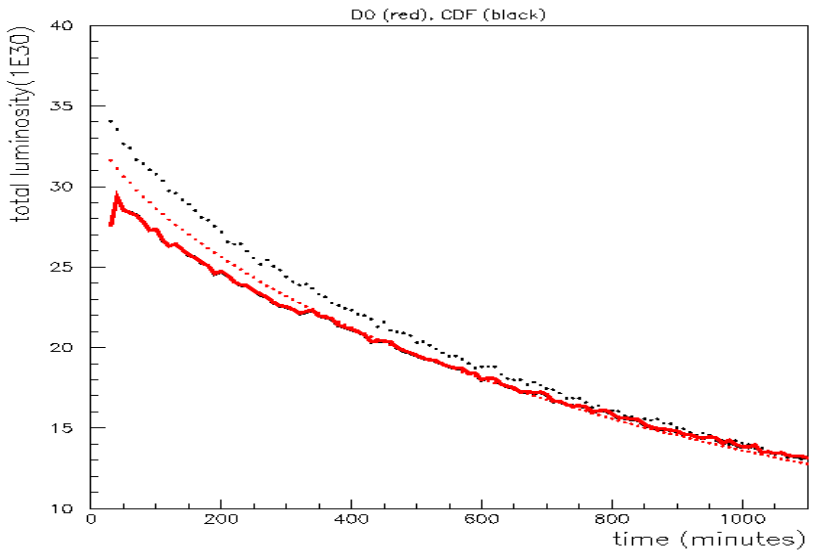
Using vertexes at DØ

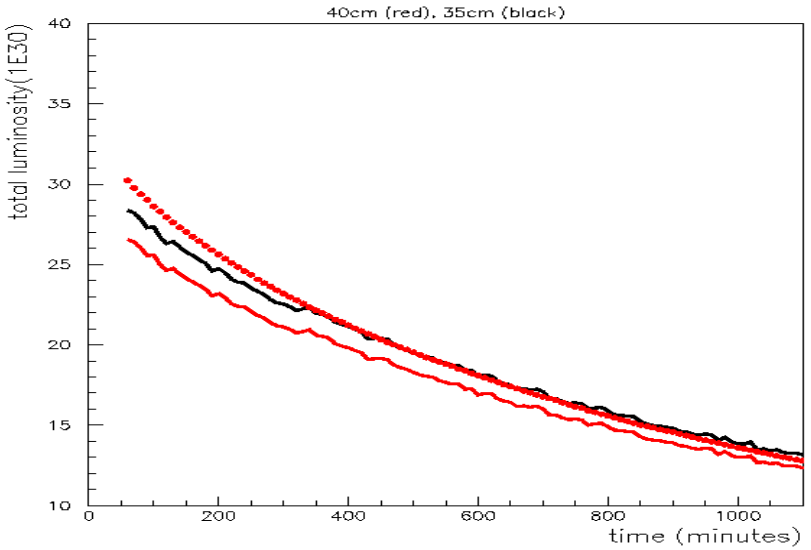


Measured at Tevatron

details here need to be studied… but we are not off by much.

One reason to solve this 3um problem





The difference in β* of 5 cm could give a clue on the difference between the BØ and DØ luminosities. I have been working with Jean Slaugther in trying to match the luminosities calculated from beams parameters to that measured in the experiments, β* is very important for that comparison.

Plans

- Keep trying to understand the difference between the two methods described in this talk.
- Here we have done the study putting all the bunches together (except for the calculation of luminosities). Look for the differences between bunches, sometimes these are very large.
- There will me an informal meeting to discuss the width of the luminous region between us, the people doing the same at CDF and the beam experts (so far they have only shown the vertex method, the results are similar but β^*~38cm).
- We have to keep doing this in a regular basis and keep communicating with beams division to make sure that they know what is that we are seeing.